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CYCLIC AND STEPPED CLIMATE CHANGES

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The climate on Earth has changed regularly due to natural causes. In the 20th century, anthropogenic impacts were also added to these natural changes due to the additional emission of greenhouse gases. To separate the natural and anthropogenic contributions to climate change, it is necessary to understand how climate changes. This paper proposes and tests a hypothesis that climate change manifests itself in two main types of fluctuations: cyclic and stepped. These two types of changes correspond to the manifestation of two main processes of climate formation: due to solar radiation (radiation component of climate) and due to the circulation of the atmosphere (component of advection). The external or cosmic factors that form the radiation component of the climate are cyclical in nature. Examples of cyclical climate fluctuations in the past are shown in the data of paleo temperatures: in the Antarctic for 850 thousand years, in Greenland for the last 40 thousand years, in Europe for the last 2000 years. To separate the composition of cyclic processes of different time scales into homogeneous components, new statistical methods have been developed: the cut-off method and the method of smoothing the amplitudes of cycles. The effectiveness of the method is tested on model examples and the results of applying the methods to the analysis and identification of patterns of paleo climate are discussed. The atmospheric circulation on the planet also changes, but not cyclically, but in steps when passing from one quasi stationary condition to another. And if significant climate changes due to fluctuations of cosmic factors can be considered as a transition from one attractor to another, then a change in circulation is a transition from one trajectory to another inside the attractor. Such a step change in circulation is also manifested in a step change in the basic climatic characteristics, especially in air temperature. To identify step changes, corresponding statistical models were developed and it was shown that these models of step changes are more effective than the currently used trend models for non-stationary conditions. Numerous examples of long-term series of observations of air temperature over the past 100 years have shown that the transition from one stationary condition (climate trajectory) to another occurred in the late 1980s. For Europe, the reason is a similar stepwise change in the North Atlantic Oscillation Index (NAO).

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